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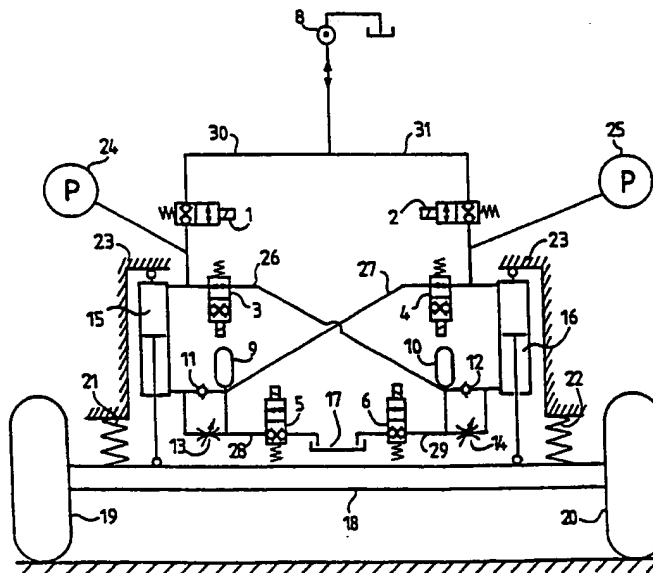
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b>  <b>B60G 19/04, 21/06</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 90/10551</b>  <b>(43) International Publication Date:</b> 20 September 1990 (20.09.90)
<b>(21) International Application Number:</b> PCT/FI90/00050 <b>(22) International Filing Date:</b> 16 February 1990 (16.02.90)  <b>(30) Priority data:</b> 891159 10 March 1989 (10.03.89) FI  <b>(71) Applicant (for all designated States except US):</b> OY SISU-AUTO AB [FI/FI]; Kuorma-Autoteollisuus, Tammissaarentie 45, SF-10300 Karjaa (FI).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only) :</b> LUOSTARINEN, Heikki [FI/FI]; Arhotie 24 F 34, SF-00950 Helsinki (FI). ÖSTRING, Esa [FI/FI]; Kuusitie 3 C 61, SF-00270 Helsinki (FI). LEHTOVUO, Tarmo [FI/FI]; Tammissaarentie 45, SF-10320 Karjaa (FI).		<b>(74) Agent:</b> OY KOLSTER AB; Stora Robertsgatan 23, P.O. Box 148, SF-00121 Helsinki (FI).  <b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.  <b>Published</b> <i>With international search report.</i>

**(54) Title:** A HYDRAULIC ARRANGEMENT TO BE LOCATED BETWEEN A BODY AND AN AXLE OF A COMMERCIAL VEHICLE

**(57) Abstract**

The invention relates to a hydraulic arrangement to be located between a body (23) and an axle (18) of a commercial vehicle. For the adjustment of the springing characteristics of the vehicle the arrangement comprises a first (15) and a second (16) hydraulic cylinder on the different sides of the body (23); a cross-connection of fluid spaces above and below the pistons of the cylinders (15, 16); a first (10) and a second (9) pressure accumulator arranged in the first (26) and the second (27) cross-connection, respectively; a first (12) and a second (11) directional valve arranged in the first (26) and the second (27) cross-connection, respectively; and a first (14) and a second (13) throttle valve arranged parallel with the first (12) and the second (11) directional valve, respectively.

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A hydraulic arrangement to be located between a body and an axle of a commercial vehicle

The present invention relates to a hydraulic arrangement to be located between a body and an axle of a commercial vehicle and to be used for the adjustment of the springing characteristics of the vehicle, as of the stabilization of shock absorption and sway, and if desired, also for the realization of lifting and lowering the body as well as for the definition of the axle weight. This arrangement comprises

- a first and a second hydraulic cylinder on different sides of the body, the cylinders being at one end fastened to the vehicle body and at the other end to the axle of the vehicle;

- a cross-connection of fluid spaces above and below the pistons of the cylinders in such a way that from the fluid space above the piston of the first cylinder there is a first connection into the fluid space below the piston of the second cylinder, and respectively, from the fluid space above the piston of the second cylinder there is a second connection into the space below the piston of the first cylinder; and

- a first and a second pressure accumulator arranged in the first and the second cross-connection, respectively, to receive or to deliver an amount of fluid corresponding to the change of the total volume of the fluid spaces of the cylinders, the fluid spaces communicating with each other.

Operations of the kind described above have generally been realized by means of separate structures, e.g. shock absorption by means of hydraulic or hydropneumatic or pneumatic dampers and sway stabili-

zation by means of different spring solutions. Lifting and lowering the body of an air spring suspended car succeeds typically by adjusting the amount of air. For the definition of axle weights, methods of various kinds have been used, most of them carried out by means of sensors measuring the elongation of loaded parts.

The object of the present invention is to provide a hydraulic arrangement by means of which the operations mentioned above can be carried out even by means of one and the same arrangement. This arrangement of the invention suitable for the adjustment of the springing characteristics of a vehicle is characterized in that it comprises

- a first and a second directional valve arranged in the first and the second cross-connection, respectively, to allow a one-way flow from the fluid space above the piston of the second cylinder into the fluid space below the piston of the second cylinder in each particular case; and

- a first and a second throttle valve arranged parallel with the first and the second directional control valve, respectively.

To complement this arrangement to include also the realization of lifting and lowering the body, the arrangement further preferably comprises a first and a second magnetic valve opening and closing a two-way connection and arranged in the first and the second cross-connection, respectively.

In this invention, the structure based on hydraulics gives good possibilities of adjusting the springing characteristics of a commercial vehicle. In commercial vehicles, a great load variation between an empty and a loaded vehicle causes problems, because the springing characteristics of a vehicle tra-

ditionally provided with leaf springs must in the first place be planned for a situation when the vehicle is loaded, which leads to a strong spring suspension in case of a partially loaded or an empty car. In this invention, the shock absorption can be influenced by adjusting the throttle valve, which makes it possible to decrease throttling and thus to adjust the shock absorption smaller when the car is empty.

Further, the possibility of adjusting the level of the vehicle body known from the air spring suspension can also be utilized at the traditional leaf spring suspension by means of the structure of the invention. Level adjustment is of importance when a vehicle is loaded from loading bridges, in which case the height of a load space can be adjusted accurately to the level of the bridge. By means of the arrangement of the invention, the level adjustment can be locked in place to the extent that an increased loading does not change the level. The level adjustment makes it possible to use also separate load spaces standing on their legs in such a way that for instance when a car is loaded with a load space it is driven under the load space with the body level lowered, after which the level is lifted until the legs of the load space rise into the air and the legs can be bent into a driving position.

The arrangement of the invention does not restrict the solution of the spring suspension, and consequently, the actual spring suspension can be carried out e.g. by means of leaf springs or air springs. When defining the axle weight in connection with air spring suspension, it is possible to release the pressure from suspension air bags, if desired.

The invention preferably unites shock absorp-

tion, sway stabilization, lifting and lowering the body as well as definition of the axle weight of a commercial vehicle into the same hydraulic circuit.

5 In the following, the arrangement of the invention for the realization of various operations will be described in detail referring to the drawing enclosed, in which the hydraulic arrangement of the invention is described partly schematically and partly as a hydraulic diagram.

10 A hydraulic arrangement of the invention comprises a first 15 and a second 16 hydraulic cylinder on different sides of a body 23, the cylinders being at one end fastened to the vehicle body 23 and at the other end to an axle 18 of the vehicle; a cross-connection of fluid spaces above and below the pistons of the cylinders 15, 16 in such a way that from the fluid space above the piston of the first cylinder 15 there is a first connection 26 to the fluid space below the piston of the second cylinder 16, and respectively, from the fluid space above the piston of the second cylinder 16 there is a second connection 27 to the space below the piston of the first cylinder 15; a first 3 and a second 4 magnetic valve opening and closing a two-way connection and arranged in the first 26 and the second 27 cross-connection, respectively; a first 10 and a second 9 pressure accumulator arranged in the first 26 and second 27 cross-connection, respectively, to receive or to deliver an amount of fluid corresponding to the change of the total volume of the fluid spaces of the cylinders 15, 16, the fluid spaces communicating with each other; a first 12 and a second 11 directional valve arranged in the first 26 and the second 27 cross-connection, respectively, to allow a one-way flow from the fluid space above the piston of the second cylinder into

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the fluid space below the piston of the second cylinder in each particular case; and a first 14 and a second 13 throttle valve advantageously adjustable and arranged parallel with the first 12 and the second 11 directional valve, respectively.

Moreover, the arrangement comprises a fluid reservoir 17 to be connected through connections 29, 28 provided with magnetic valves 6, 5 with the first 26 and the second 27 cross-connection, respectively, to equalize the pressure of the pressure accumulators 9, 10 connected therewith to the atmospheric pressure, and a hydraulic pump 8 to be connected through connections 30, 31 provided with magnetic valves 1, 2 with the fluid space above the piston of the first 15 and the second 16 hydraulic cylinder, respectively, to pressurize the first 26 and the second 27 cross-connection and the pressure accumulators 10, 9 attached to them.

The arrangement includes further a first 24 and a second 25 pressure sensor arranged to measure the pressure of the fluid space above the piston of the first 15 and the second 16 hydraulic cylinder, respectively.

Shock absorption and sway damping can be realized by means of a circuit of the invention when the magnetic valves 1, 2, 5 and 6 are closed and the magnetic valves 3 and 4 are open. At simultaneous bump travel of wheels 19 and 20 of the vehicle, the fluid then flows from above the piston of the cylinder 15 below the piston of the cylinder 16 through the directional valve 12 in the first place, and respectively, the same amount of fluid flows also from the cylinder 16 into the cylinder 15 through the directional valve 11, whereby the damping at bump travel is caused by flow resistances of the pipe system



only.

At rebound travel the flow takes place in the opposite direction through the throttle valves 13 and 14 only with the directional valves in the closing direction, whereby the damping is greater than at bump travel and it can be adjusted by adjusting the throttling.

If the springiness is one-sided, i.e. if the vehicle is swaying, a fluid volume corresponding to the bump travel flows from the cylinder 15 on the side of a bump travel wheel, e.g. 19, through the magnetic valve 3 into the pressure accumulator 10, and a fluid volume corresponding to the rebound travel flows from the cylinder 16 on the side of the rebound travel wheel 20 through the throttle valve 14 also into the pressure accumulator 10, whereby the pressure of the pressure accumulator 10 increases. In the case described, fluid flows from the pressure accumulator 9 into the cylinders and the pressure of the pressure accumulator 9 decreases. The pressure difference between the accumulators 10 and 9 creates a pair of opposing forces preventing the cylinders from swaying, i.e. a stabilization of the sway.

The body 23 can be lifted with respect to the axle 18 by opening the magnetic valves 1, 2, 5 and 6 and by closing the magnetic valves 3 and 4. The atmospheric pressure prevails then in the pressure accumulators and the fluid spaces below the pistons of the cylinders 15 and 16 are communicating with the reservoir 17. When the hydraulic pump 8 pumps more fluid through the magnetic valves 1 and 2 into the fluid space above the pistons of the cylinders 15 and 16, the pistons push downwards and the body rises with respect to the axle. The body can be lowered with respect to the axle by closing the valves 1 and

2 and by opening the valves 3 and 4 with the valves 5 and 6 still open. The lowering is only restricted by the stroke of the cylinders or by the force caused by springs 21 and 22.

5           The definition of the axle weight can be carried out by measuring the pressure prevailing above the piston of the cylinders 15 and 16. The measuring is begun by opening the magnetic valves 5 and 6 and by closing the magnetic valves 3 and 4 after that,  
10 while the magnetic valves 1 and 2 are closed and the vehicle is unloaded. The circuit gets the atmospheric pressure again when the magnetic valves 5 and 6 are opened. At this stage, only the springs 21 and 22 bear the load of the body, i.e. the axle weight of  
15 the axle in question. By closing the valves 3 and 4 the situation is locked, whereby the pistons of the hydraulic cylinders 15 and 16 cannot move in the upper or lower direction, i.e. in bump travel or rebound travel direction, and thus, the spring force  
20 cannot change, which means that the load increased when loading the vehicle is borne only by the pressure increased above the piston in the cylinders, which pressure can be measured by means of pressure sensors 24 and 25 of any conventional type, e.g.  
25 electrical or mechanical sensors.

          The arrangement of the invention has been described above in connection with one exemplifying arrangement only and it is to be understood that the invention can be modified rather extensively, without  
30 departing from the scope defined by the claims enclosed, however.

## Claims:

1. A hydraulic arrangement to be located between a body (23) and an axle (18) of a commercial vehicle, which arrangement comprises

5 - a first (15) and a second (16) hydraulic cylinder on different sides of the body (23), the cylinders being at one end fastened to the vehicle body (23) and at the other end to the axle (18) of the vehicle;

10 - a cross-connection of fluid spaces above and below the pistons of the cylinders (15, 16) in such a way that from the fluid space above the piston of the first cylinder (15) there is a first connection (26) into the fluid space below the piston of the second cylinder (16), and respectively, from the fluid space above the piston of the second cylinder (16) there is a second connection (27) into the space below the piston of the first cylinder (15); and

15 20 - a first (10) and a second (9) pressure accumulator arranged in the first (26) and the second (27) cross-connection, respectively, to receive or to deliver an amount of fluid corresponding to the change of the total volume of the fluid spaces of the cylinders (15, 16), the fluid spaces communicating with each other;

25 characterized in that it further comprises

30 - a first (12) and a second (11) directional valve arranged in the first (26) and the second (27) cross-connection, respectively, to allow a one-way flow from the fluid space above the piston of the second cylinder into the fluid space below the piston of the second cylinder in each particular case; and

35 - a first (14) and a second (13) throttle valve

arranged parallel with the first (12) and the second (11) directional valve, respectively.

2. An arrangement according to claim 1,  
c h a r a c t e r i z e d in that it further com-  
5 prises a first (3) and a second (4) magnetic valve  
opening and closing a two-way connection arranged in  
the first (26) and the second (27) cross-connection,  
respectively.



# INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 90/00050

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC <b>IPC5: B 60 G 19/04, 21/06</b>																	
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched<sup>7</sup></div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; border-bottom: 1px solid black; padding: 2px;">Classification System</td> <td style="border-bottom: 1px solid black; padding: 2px;">Classification Symbols</td> </tr> <tr> <td style="padding: 5px;">IPC5</td> <td style="padding: 5px;">B 60 G</td> </tr> </table> <div style="border-top: 1px solid black; padding: 5px;">           Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched<sup>8</sup>   <b>SE,DK,FI,NO classes as above</b> </div>			Classification System	Classification Symbols	IPC5	B 60 G											
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IPC5	B 60 G																
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; padding: 2px;">Category *</th> <th style="width: 70%; padding: 2px;">Citation of Document,<sup>11</sup> with indication, where appropriate, of the relevant passages<sup>12</sup></th> <th style="width: 20%; padding: 2px;">Relevant to Claim No.<sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">FR, A1, 2252228 (AUTOMOTIVE PRODUCTS LIMITED) 20 June 1975, see page 4, line 34 - line 36; page 5, line 1 - line 7; figures 2,3 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">AU, B, 17948/76 (THORNHILL, F.W.) 28 June 1979, see page 5, line 15 - line 21 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">FR, A1, 2503641 (AUTOMOBILES PEUGEOT, AUTOMOBILES CITROEN) 15 October 1982, see figure 1 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">DE, A1, 2048323 (DAIMLER-BENZ AG) 6 April 1972, see claim 1 --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> </tbody> </table>			Category *	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	A	FR, A1, 2252228 (AUTOMOTIVE PRODUCTS LIMITED) 20 June 1975, see page 4, line 34 - line 36; page 5, line 1 - line 7; figures 2,3 --	1	A	AU, B, 17948/76 (THORNHILL, F.W.) 28 June 1979, see page 5, line 15 - line 21 --	1	A	FR, A1, 2503641 (AUTOMOBILES PEUGEOT, AUTOMOBILES CITROEN) 15 October 1982, see figure 1 --	1	A	DE, A1, 2048323 (DAIMLER-BENZ AG) 6 April 1972, see claim 1 --	1
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A	FR, A1, 2503641 (AUTOMOBILES PEUGEOT, AUTOMOBILES CITROEN) 15 October 1982, see figure 1 --	1															
A	DE, A1, 2048323 (DAIMLER-BENZ AG) 6 April 1972, see claim 1 --	1															
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><b>* Special categories of cited documents:<sup>10</sup></b></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>																	
<b>IV. CERTIFICATION</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 2px;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border-bottom: 1px solid black; padding: 2px;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="padding: 5px; text-align: center;">7th June 1990</td> <td style="padding: 5px; text-align: center;">1990 -06- 18</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 2px;">International Searching Authority</td> <td style="border-bottom: 1px solid black; padding: 2px;">Signature of Authorized Officer</td> </tr> <tr> <td style="padding: 5px; text-align: center;">SWEDISH PATENT OFFICE</td> <td style="padding: 5px;">Rune Kirsten </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	7th June 1990	1990 -06- 18	International Searching Authority	Signature of Authorized Officer	SWEDISH PATENT OFFICE	Rune Kirsten							
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International Searching Authority	Signature of Authorized Officer																
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 2684254 (H.W. GOSS) 20 July 1954, see figure 9  --  -----	1

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 90/00050**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 90-05-07. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A1- 2252228	75-06-20	GB-A- 1484673	77-09-01
AU-B- 17948/76	79-06-28	NONE	
FR-A1- 2503641	82-10-15	NONE	
DE-A1- 2048323	72-04-06	FR-A-B- 2112232	72-06-16
		GB-A- 1335758	73-10-31
		US-A- 3752497	73-08-14
US-A- 2684254	54-07-20	NONE	